INTRODUCTION

The Idaho Ground Water Vulnerability Project was initiated by the Idaho Department of Health and Welfare to rate areas within the state for their ground water pollution potential. The goals of the Project are to: (1) assign priorities for development of ground water management and monitoring programs; (2) build public awareness of vulnerability of ground water to contamination; (3) assist in the development of regulatory programs; and (4) provide access to technical data through the use of a GIS (geographic information system). Programs which could utilize vulnerability maps include underground storage tanks, wellhead protection, ground water monitoring, public water supplies, agricultural chemicals, waste water management, best management practice (BMP) implementation and development, hazardous waste management, state and federal superfund programs, land use planning, State underground tank insurance agencies, and public information.

Making the Idaho Ground Water Vulnerability Project a reality required the effort of a number of agencies. The IDHW identified the program needs, but they did not have all the tools to make it work. The Idaho Department of Water Resources (IDWR), the U.S. Geological Survey (USGS) and the U.S.D.A. Soil Conservation Service (SCS) assisted in the development of the vulnerability maps by lending their expertise in their various fields of specialization. Mapping was originally performed on a pilot project basis for the Lake Walcott 1:100,000 scale quadrangle. Once that project was successfully completed in 1988, mapping was extended across the entire Snake River Plain and tributary valleys.

The term vulnerability is a combination of two concepts related to the assessment of ground water pollution potential; hydrogeologic susceptibility and contaminant loading potential. Hydrogeologic susceptibility includes the naturally-occurring factors related to the estimation of pollution potential such as depth-to-water, soils, vadose zone, or aquifer media. Contaminant loading potential includes man made sources of pollution such as underground petroleum storage tanks or feedlots. Contaminant loading potential is important for vulnerability assessment, because irrespective of susceptibility, ground water contamination cannot occur without contaminant loading. This study performs most of its ratings based on hydrogeologic susceptibility, but also incorporates information related to contaminant loading potential. Future work will address contaminant loading potential in greater detail.

1) Area of Study

This study developed digital maps in all or part of twenty (20) 1:100,000-scale quadrangles on the Snake River Plain and surrounding tributary valleys (Figure 1). The 20 quadrangles cover about 33,980 mi^2 and extend from the Idaho-Oregon border

Idaho Snake River Plain
Groundwater Vulnerability Study Area
100k Quads Affected

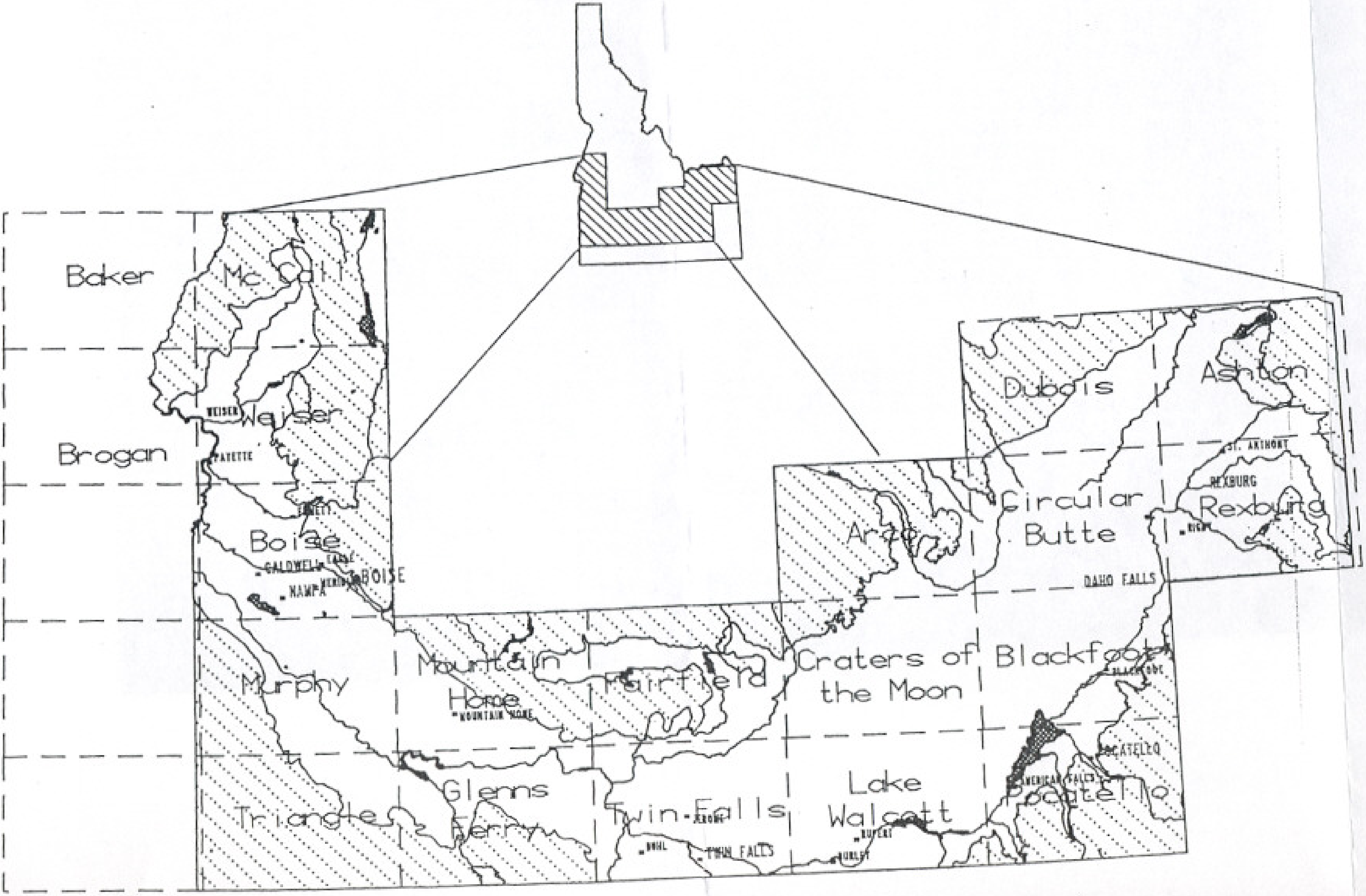

Figure 1: Location map of study area

eastward to the Idaho-Wyoming border. The Snake River Plain encompasses nearly 15,600 mi^2 of the total 33,980 mi^2 (Maupin, in press-a; Maupin, in press-b). The tributary valleys cover almost 3,700 mi^2 of the total 33,980 mi^2. Mountainous areas, for which no depth-to-water data were available, cover nearly 14,680 mi^2 of the total quad area. Included are all or parts of the Arco, Ashton, Blackfoot, Boise, Brogan, Circular Butte, Craters of the Moon, Dubois, Fairfield, Glenns Ferry, Lake Walcott, McCall, Mountain Home, Murphy, Pocatello, Rexburg, Triangle, Twin Falls, Vale, and Weiser quadrangles.

The Eastern Snake River Plain is a structural downwarp containing a complex of calderas with a great thickness of silicic volcanic rocks overlain by several thousand feet of Quaternary basalt flows and interbedded layers of gravel, sand, silt, and clay (Mabey, 1982). Occurrence of basalt flows decreases westwardly across the Eastern plain, with occurrence of alluvial deposits increasing. The Eastern plain is underlain by the Snake River Plain Aquifer (Lindholm, 1986; Lindholm & others, 1988). The Western Snake River Plain is generally considered to be a fault-bounded depression with normal faults forming major segments of both edges of the plain (Malde, 1965). Deep oil and geothermal wells drilled on the Western Snake River Plain revealed lacustrine sediments several hundred meters thick underlain by 1,000 to 2,000 meters of basalt flows with interbedded sediments (Mabey, 1982). The Western Snake River Plain is underlain by several aquifers under different depths and conditions. Ground water resources located under both the Eastern and Western Snake River Plain are a major source of water for agricultural, industrial, municipal, and domestic uses (Lindholm, 1986). Perched ground water zones occur locally throughout the both the Eastern and Western Snake River Plain.

Also mapped were tributary valleys to the Snake River Plain which were located within the quadrangle boundaries. The valleys are mostly underlain by alluvial sediments with some basalt flows, predominantly where the valleys meet the Snake River Plain (Maupin, in press-a; Maupin, in press-b). Ground water is mostly unconfined; some confining conditions exist where local clay lenses are present. Most water use is for domestic, stock, and irrigation purposes. Ground water in the tributary valleys generally flows down the valleys toward the Snake River Plain.

2) Use of Computers

An automated geographic information system (GIS) was utilized in the development of the ground water vulnerability maps because it is an efficient way to evaluate the relationships between various environmental, geological, and land use parameters. Not only is a GIS a useful tool for observing and analyzing the spacial relationships of data, but once the data layers are developed they can be used by a multitude of other programs for a variety of different applications, and can be readily adapted as more information becomes available.

The Idaho Ground Water Vulnerability Project used ARC/INFO[1] software for the development of the associated map coverages. ARC/INFO consists of two data bases that work together to keep track of, and analyze, spatially related data consisting of features (points, lines, or polygons). ARC is the graphics part of the system which draws features in their correct positions. INFO, the tabular data base, is the bookkeeping part of the system that consists of attributes such as well depth, water levels, soil information, irrigation practices, etc. ARC/INFO contains software capable of editing, plotting, estimating, and contouring.

Data falling into a specific category (such as soils or recharge) were built into a data "layer." Then, using GIS techniques, several layers were superimposed with the spatial and relational characteristics of each layer being combined. A composite map with final vulnerability ratings was generated utilizing information from each layer.

3) **Use of DRASTIC**

The Vulnerability Project developed a modified form of DRASTIC (Aller et. al., 1985) which was originally produced by the National Water Well Association under contract to the U.S. Environmental Protection Agency (EPA). The DRASTIC model evaluates the ground water pollution potential of a given hydrogeologic setting based on a set of defined characteristics, along with ratings or "weights" assigned to those characteristics. These ratings are based on the perceived contribution of a given characteristic to ground water vulnerability or pollution potential. DRASTIC is an acronym for the various criteria which the model incorporates. These are; depth-to-water (D), recharge (R), aquifer media (A), soils media (S), topography (T), impact of the vadose zone (I), and hydraulic conductivity of the aquifer (C).

This project utilized three layers which resemble those used by DRASTIC (depth-to-water, soils, and recharge), but differ greatly from DRASTIC in that they used different sources of information, a finer mapping scale, and a different point rating scheme. The soils layer had much more detailed, varied, and soils-specific data than in the original DRASTIC soils data layer. This was because the Idaho Project used the

[1]Use of brand names in this publication is for identification purposes only and does not constitute endorsement by the authors or their respective agencies.

STATSGO (State Soil Geographic Database) and SOILS-5 databases developed by the Soil Conservation Service. The Recharge layer varied significantly from DRASTIC because it incorporated irrigation practices as the largest contributor to recharge because of the typically low precipitation in the Snake River Plain. It too was developed at a much more detailed level than that used by DRASTIC. The depth-to-water layer is different from that used in DRASTIC because this project used water level information from over 1200 wells, and generated the layer using a statistical KRIGING package and computer contouring techniques. All three layers used different point rating systems, and were rated relative to each other differently than DRASTIC. This project also varied from DRASTIC in its use of a GIS, which allowed spacial analysis and advanced computer-aided mapping techniques during development of the vulnerability maps. DRASTIC was generated through standard cartographic techniques.

The Vulnerability Project did not develop layers for the vadose zone, aquifer media, hydraulic conductivity, and topography. The vadose zone was not developed because it was not cost effective to build that data layer using existing data sources. However, the vadose zone layer is believed to be a crucial layer in susceptibility assessment, and much emphasis will be focused on developing this layer in the future. The aquifer media and hydraulic conductivity layers were not developed because it was not cost effective to build the layers, and it was believed that available sources of information were not of high enough quality. The topography layer was not developed because data were not readily available to develop this layer in a cost effective manner, and because it was believed this layer is not as important in ground water susceptibility determination and hence received a lower priority for development. Depending on funding levels and available resources, all of these layers may be developed in the future.

DESCRIPTION OF DATA LAYERS

The following is an in-depth description of the depth-to-water, recharge, and soils data layers used by the Idaho Ground Water Vulnerability Project for the Snake River Plain study area.

1) Depth-to-water

a) Introduction

Evaluation of the depth to first-encountered water below land surface is a significant element in evaluating susceptibility of ground water to contamination, because areas where the ground water is close to the surface typically have a higher